Transport across plasma membrane

The plasma membrane is a selectively permeable barrier between the cell and the extracellular environment. Its permeability properties ensure that essential molecules such as glucose, amino acids, and lipids readily enter the cell, metabolic intermediates remain in the cell, and waste compounds leave the cell. In other words, plasma membranes are **selectively permeable**—they allow some substances through but not others. Selectively permeable or semi-permeable means that only certain substances which are able to pass through the membrane. If the membrane were to lose this selectivity, the cell would no longer be able to maintain homeostasis, or to sustain itself, and it would be destroyed.

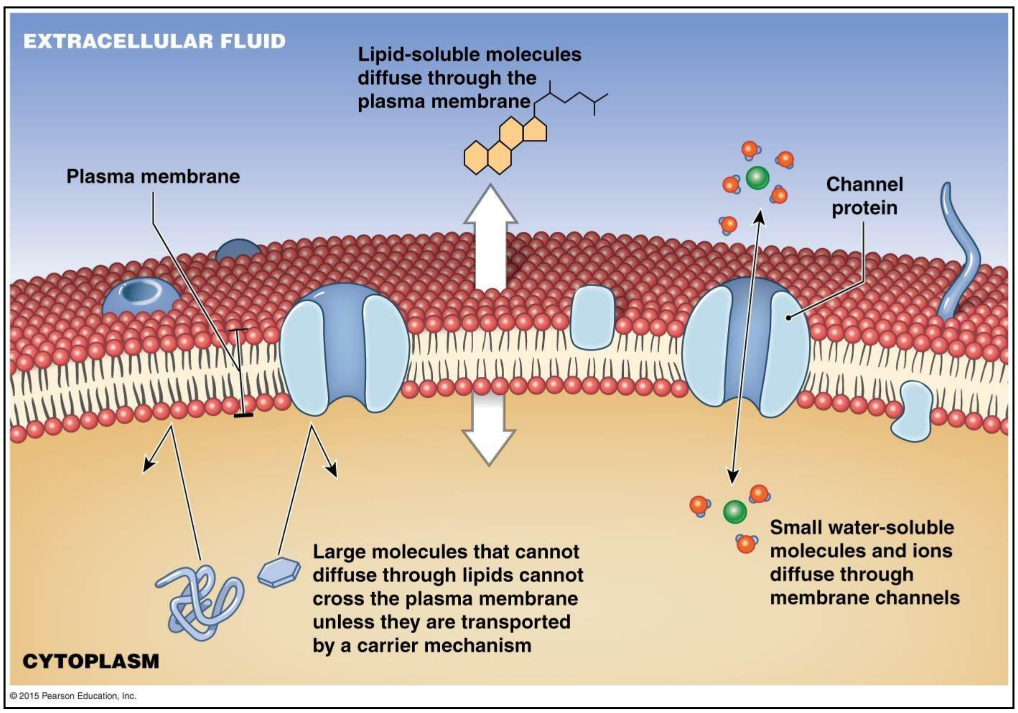

Fig: Plasma Membrane ….Selective permeable

Two types of transport processes are

Transporting substances across the plasma membrane can require that the cell use some of its energy. If energy is used, the transport is called *active*. If molecules can pass through the plasma membrane without using energy, the molecules are using *passive* transport.

Passive transport

- Substances move down its concentration or electrical gradient to cross the membrane using its own kinetic energy.
- Kinetic energy is intrinsic to the particles that are moving.
- No input of energy from the cell.

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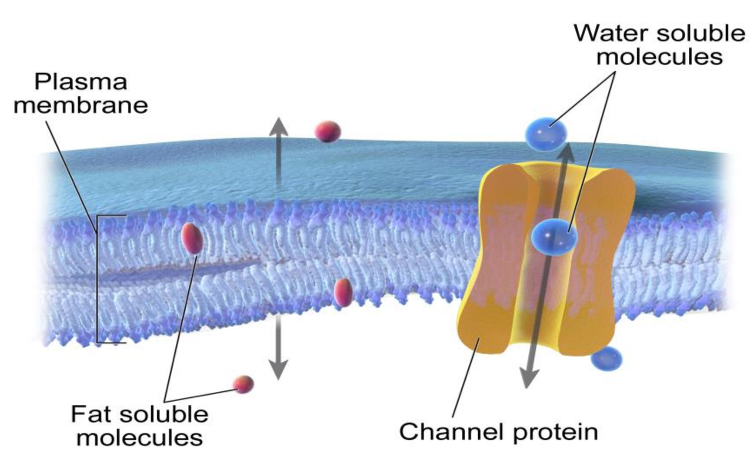
A membrane can allow molecules to be passively transported through it in three ways: diffusion, osmosis, and filtration.

Diffusion : Diffusion is a passive process of transport. A single substance tends to move from an area of high concentration to an area of low concentration until the concentration is equal across a space. Materials move within the cell's cytosol by diffusion, and certain materials move through the plasma membrane by diffusion. Diffusion expends no energy. On the contrary, concentration gradients are a form of potential energy, dissipated as the gradient is eliminated. Each separate substance in a medium, such as the extracellular fluid, has its own concentration gradient independent of the concentration gradients of other materials. In addition, each substance will diffuse according to that gradient. Within a system, there will be different rates of diffusion of the different substances in the medium.



Diffusion Across the Plasma Membrane

Osmosis: Osmosis is a special case of diffusion. Water, like other substances, moves from an area of high concentration to one of low concentration. Most cell membranes are permeable to water, and since the diffusion of water plays such an important role in the biological function of any living being, a special term has been coined for it — *osmosis*. It is a net movement of solvent through a selectively permeable membrane. In living systems, the solvent is water, which moves by osmosis across plasma membranes from an area of higher water concentration to lower concentration. In other words water move through a selectively permeable membrane from an area of lower solute concentration to an area of higher solute concentration. Water molecules pass through a plasma membrane in two ways By moving through the lipid bilayer and by moving through aquaporins (integral membrane proteins that function as water channels).

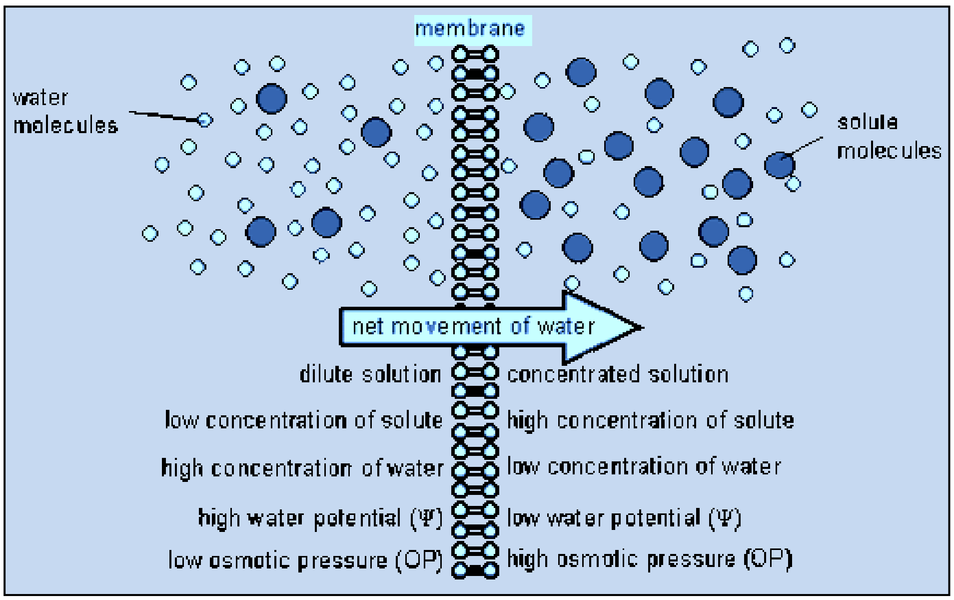


Fig: Osmosis

Filtration: The last form of passive transport is used most often in the capillaries. Capillaries are so thin (their membranes are only one cell thick) that diffusion easily takes place through them. But remember that animals have a blood pressure. The pressure at which the blood flows through the capillaries is enough force to push water and small solutes that have dissolved in the water right through the capillary membrane. So, in essence, the capillary membrane acts as filter paper, allowing fluid to surround the body's cells and keeping large molecules from getting into the tissue fluid.

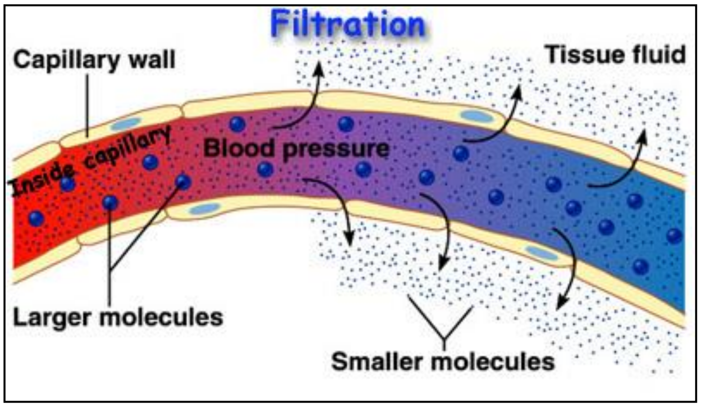


Fig: Filtration

Key Points of Passive Transport

- Plasma membranes are selectively permeable; if they were to lose this selectivity, the cell would no longer be able to sustain itself.
- In passive transport, substances simply move from an area of higher concentration to an area of lower concentration, which does not require the input of energy.
- Concentration gradient, size of the particles that are diffusing, and temperature of the system affect the rate of diffusion.
- Some materials diffuse readily through the membrane, but others require specialized proteins, such as channels and transporters, to carry them into or out of the cell.

Active Transport

Active transport is the movement of dissolved molecules into or out of a cell through the cell membrane, from a region of lower concentration to a region of higher concentration. The particles move against the concentration gradient, using energy released during respiration.

Sometimes dissolved molecules are at a higher concentration inside the cell than outside, but, because the organism needs these molecules, they still have to be absorbed. **Carrier proteins** pick up specific molecules and take them through the cell membrane against the concentration gradient.

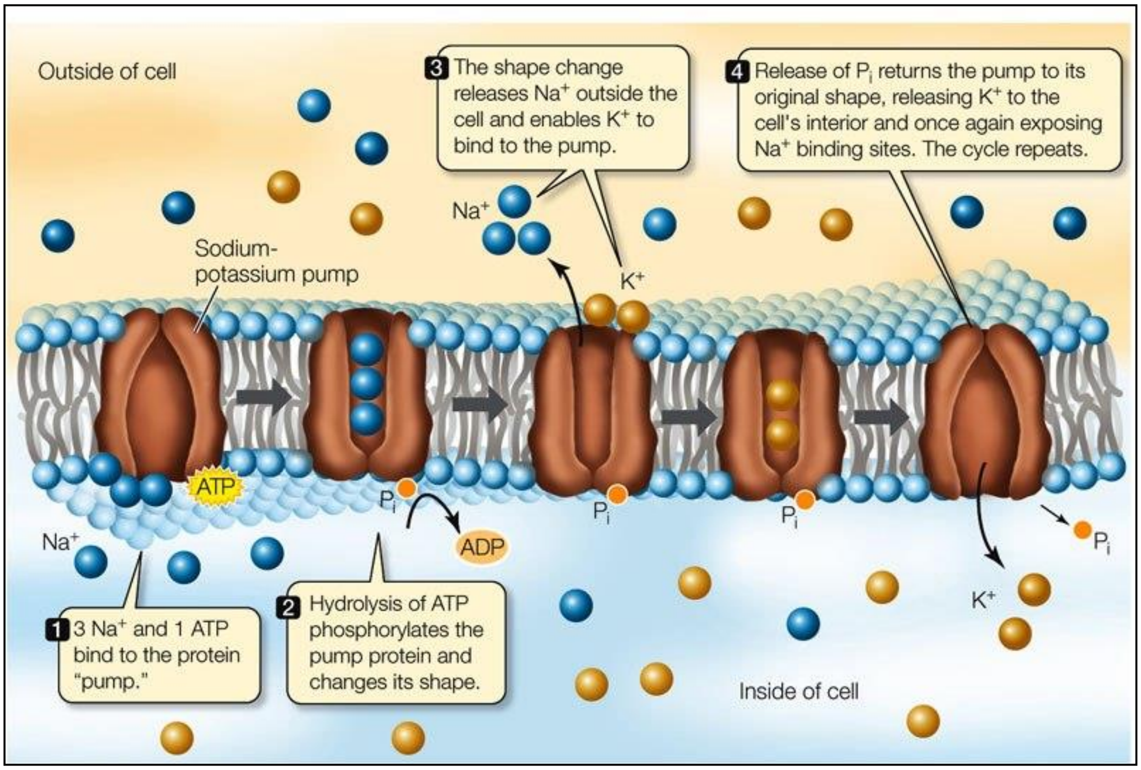


Fig: Active Transport

There are two types of active transport: primary and secondary.

Primary active transport, also called direct active transport, directly uses chemical energy (such as from adenosine triphosphate or ATP in case of cell membrane) to transport all species of solutes across a membrane against their concentration gradient. Uptake of glucose in the human intestines is an example of primary active transport. Other sources of energy for primary active transport are redox energy (chemical reaction such as oxidation and reduction) and photon energy (light). An example of primary active transport using redox energy is the mitochondrial electron transport chain that uses the reduction energy of NADH (nicotinamide adenine dinucleotide, reduced form) to move protons across the inner mitochondrial membrane against their concentration gradient. An example of primary active transport using light energy is the proteins involved in photosynthesis.

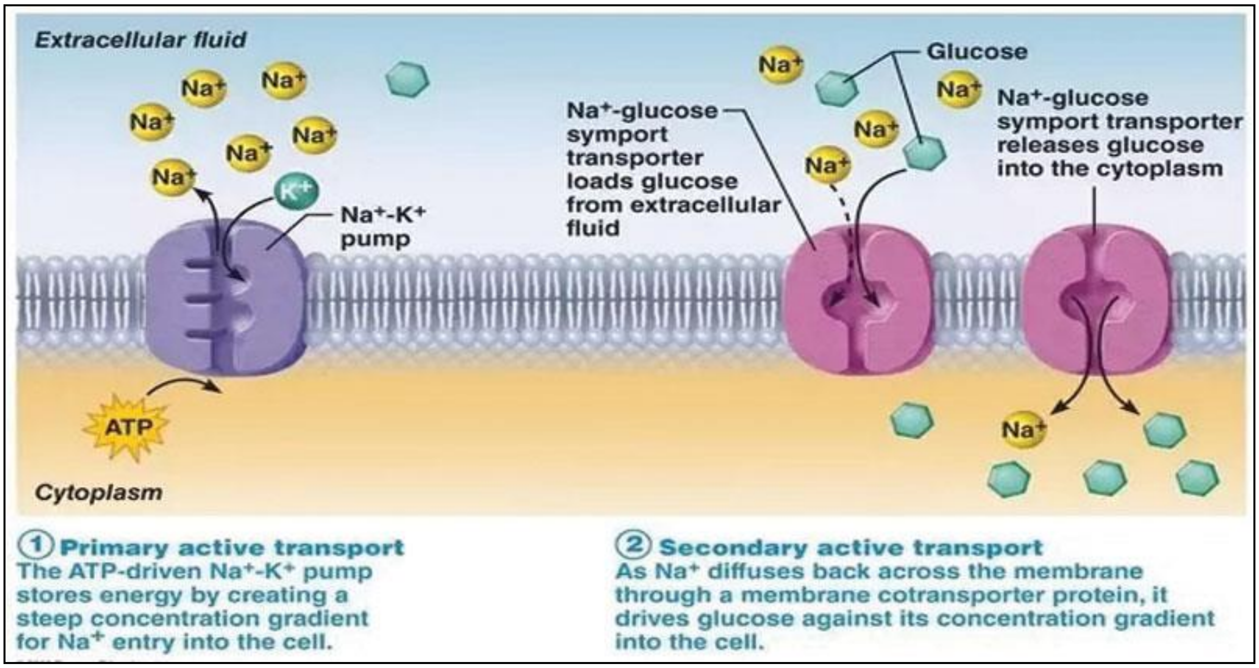


Fig: Primary and Secondary active transport

Key Points for Primary active transport:

- The sodium-potassium pump moves K+ into the cell while moving Na+ at a ratio of three Na+ for every two K+ ions.
- When the sodium-potassium- ATPase enzyme points into the cell, it has a high affinity for sodium ions and binds three of them, hydrolyzing ATP and changing shape.
- As the enzyme changes shape, it reorients itself towards the outside of the cell, and the three sodium ions are released.
- The enzyme's new shape allows two potassium to bind and the phosphate group to detach, and the carrier protein repositions itself towards the interior of the cell.
- The enzyme changes shape again, releasing the potassium ions into the cell.
- After potassium is released into the cell, the enzyme binds three sodium ions, which starts the process over again.

Secondary active transport, on the other hand, allows one solute to move downhill (along its electrochemical potential gradient) in order to yield enough entropic energy to drive the transport of the other solute uphill (from a low concentration region to a high one). This is also known as coupled transport, as opposed to noncoupled or uniport transport where transport of a single component is facilitated. There are two main forms of coupled transport: antiport and symport. In antiport two species of ion or other solutes are pumped in opposite directions across a membrane and in symport transport two species move in the same direction.

Key Points for Secondary active transport

- The electrical and concentration gradients of a membrane tend to drive sodium into and potassium out of the cell, and active transport works against these gradients.
- To move substances against a concentration or electrochemical gradient, the cell must utilize energy in the form of ATP during active transport.
- Primary active transport, which is directly dependent on ATP, moves ions across a membrane and creates a difference in charge across that membrane.
- Secondary active transport, created by primary active transport, is the transport of a solute in the direction of its electrochemical gradient and does not directly require ATP.
- Carrier proteins such as uniporters, symporters, and antiporters perform primary active transport and facilitate the movement of solutes across the cell's membrane.

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